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ABSTRACT

Prepared for a 1984 Organisation for Economic Cooperation and Development (OECD) conference, this report begins by briefly describing research findings and proposals and recommendations for research on education and the new information technologies in selected member countries, i.e., the United States, France, the United Kingdom, and Australia; these descriptions reveal trends in which certain similarities can be observed. Research proposals and priorities for each country are introduced so that possible topics for international cooperation can be identified. The findings of a questionnaire sent to selected member country research institutions are summarized. This questionnaire, which sought information about the nature and scope of research and development programs, asked research institutions to classify their work within the following categories: hardware for educational purposes; systems for educational applications; educational application software; the learning process; social and psychological issues; and professional development and training programs. On the basis of the preceding information and conclusions, possible topics and arrangements for research on a cooperative international basis are suggested. (MBR)

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International Conference on Education and New Information Technologies

Château de la Muette
9th-12th July 1984

Overview in Selected Member Countries, Analytical Report on the Survey and Proposals for International co-operation

RESEARCH AND DEVELOPMENT RELATING TO THE EDUCATIONAL APPLICATIONS OF NEW INFORMATION TECHNOLOGIES

(Note by the Secretariat)

1. At the first meeting of the Advisory Group of national representatives and experts held on 13th-14th September, 1982, a proposal was made to include in CERI Project 1 a specific activity on "the nature and size of current investment in R & D on advanced educational applications of the computer" (CERI/NT/82.06 paras. 17 to 19). This proposal was endorsed by the CERI Governing Board at its 27th Session in November 1982 [CERI/CD/M(82)2 para. 74 (ii)], one of the underlying assumptions being that, in addition to its intrinsic value, such information, if it would be put together, would provide the basis for any discussion about possibilities for future international co-operation in this area.

2. For the purpose, a questionnaire (CERI/NT/83.06) was drawn up and sent to a number of research institutions via the authorities concerned in countries interested. This paper briefly analyses the responses received by

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the Secretariat, then suggests some possible forms of international co-operation. Annex 2 to CERI/NT/84.04 provides, in a uniform layout, some key information on R & D activities by each of the institutions participating in the survey.

3. This report, prepared by the Secretariat, will serve as a background report for the Plenary session on Theme 4.

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INTRODUCTION

1. Over the last 10 years, computers and telecommunications have widely infiltrated socio-economic activity in services, communications and production. The process is accelerating, perhaps more rapidly than might have been expected. This confronts the education system with new industrial, marketing, economic and cultural pressures, and with new social expectations. The challenge is all the greater as the market is already lavishly supplied with video games, calculators, video recorders, and microcomputers with an educational character liable, unless something is done, to create a new sphere of "education" outside the formal system.

2. During the 1960s and 1970s research was already in hand on audiovisual applications to education and on teaching applications of computers, in order to identify more closely their potential. Nowadays, the background to research and development here is naturally very different. Programmes are generally designed:

i) To advance the application of information technology to generally accepted educational purposes;

ii) To facilitate the incorporation of information technology in the educational process as an end in itself, to meet the vital requirement that young people should acquire awareness of, and familiarity with, information technology;

iii) To encourage, in particular, developments and applications which support other social aims, such as improving equality of opportunity and, conversely, to indicate instances in which developments might have the opposite effect;

iv) To advance our understanding of the learning process, of the acquisition of "false knowledge", particularly in relation to computers as a learning tool.

3. However the ultimate aims of R & D programmes are defined, the direction of development of information technology will not be determined primarily by educational considerations but will result from outside pressures and influences: hence the strategy for educational R & D must be to maximise the educational benefits of developments taking place external to education.

4. At present there is a wide spectrum of activity in some developed countries but the programmes which have been embarked upon, and which are showing evidence of considerable effect, are not in the main based upon research. They are to a great extent developmental; the advent of the new information technologies has been so rapid, and their relevance to education so manifest, that school systems, teachers, pupils and parents, encouraged by direct government action, have adopted them with enthusiasm on a sufficient scale to make this one of the most significant influences on education in recent years. This is not of course to say that the effect is universal, or even widespread; change in education is slow, and as with any innovation there are plenty of questioning voices. In order to provide the answers to those questions, and in order to give sound advice to the innovators, a broad programme of research and of training linked to research is necessary.

5. Indeed, the nature of research in an area such as this is dependent on there being a range of activity in the field, and good research should be related to work going on in the teaching environment and should also itself offer opportunities for associated training, not only of potential research workers but also of teachers and others who need to come to terms with the new developments. Educational research can seldom be conducted at arms length, and such a stance would be wholly inappropriate in this area.

6. The following report starts by presenting some proposals on the R & D carried out in selected countries, revealing trends in which certain similarities can be observed. The second chapter reviews the findings of the survey of Member-country research institutions. On the basis of the information and conclusions of Chapters I and II, the report ends by suggesting possible topics and arrangements for research and development on a co-operative international basis.

Chapter I

FINDINGS AND PROPOSALS FOR SELECTED COUNTRIES

7. Certain governments have recently sought to find out more about how far the new technologies have developed in their education systems, and to assess recent experiments. Various agencies were accordingly requested to suggest what future guidelines should be laid down so as to achieve the best possible degree of control over the introduction of these technologies into education and to maximise their educational potential. From all the resulting reports, a number of conclusions for R & D emerge around the following points.

Need to Develop Research

8. In the United States, in October 1980, the Office of Technology Assessment (OTA) was instructed by the United States Congress to review the potential role of new information technologies in education. Reporting in November 1982 (US Congress, Office of Technology Assessment, Informational Technology and its Impact on American Education), the OTA noted that "in the late 1960s, the Federal Government funded a number of research and development projects in the use of computer assisted instruction. Over the last decade, Federal funding for R & D in educational information technology has dropped precipitously"... "Much remains to be learned about the educational and psychological effects of technological approaches to instruction. Not enough experience has been gained with the new information technology to determine how that technology can most benefit learners or to predict possible negative effects of its use. Given this insufficient experience, caution should be exercised in undertaking any major national effort, whether Federally inspired or not, to introduce these new technologies into education". The OTA advised Congress to consider developing policies designed to ensure optimum use of technology and i) directly to support R & D in those areas; ii) to encourage private sector investment both from the foundations and from industry; or iii) encourage a combination of both by using Federal funding to leverage private investment.

9. In November 1982, the national Pittsburg conference "Computers in Education: Realising the potential" sponsored by the United States Department of Education came essentially to the same conclusions as the earlier OTA work: "Realising the full potential of the computer in education requires ground-breaking research that will allow educators and manufacturers to proceed confidently in the development of advanced computer-based materials for the schools. Earlier Federally-supported research provided the basis for the computer-aided instruction of the last decade and a half. Another such

research programme is now needed to take advantage of the vastly increased capability of affordable computers" (Computers in Education: Realising the Potential, US Government Printing Office, June 1983).

10. In June 1983, M.W. Sage and D.J. Smith presented a report to the United Kingdom Social Science Research Council (SSRC) entitled "Microcomputers in Education, a Framework for Research", one of whose conclusions was that "much recent development has taken place in the absence of substantial research. Attention is drawn to the lack of a formal basis for the design of learning experiences ... It is argued that the fundamental need is for research which will contribute to the information base and theoretical models which will improve the design and implementation of learning experience based on information technology applications in a variety of contexts".

11. In France, in October 1981, Y. Le Corre and C. Pair presented the Minister of Education with a report entitled "L'introduction de l'informatique dans l'éducation nationale" (Introducing computers into national education) (Service de l'Information du Ministère) in which they stated that "research on teaching applications of computers should be developed and enhanced with a view to:

-- Developing worthwhile facilities, with an eye to product quality and to remedial applications;

-- Preparing for the cultural and industrial effects;

-- Controlling adverse aspects, such as accentuated inequalitites, robotisation, threats to privacy".

12. In November 1983, R. Carraz presented the French Minister of Industry and Research with a mission report "Recherche en éducation et en socialisation de l'enfant" (Research on child education and socialisation) (La Documentation Française, Paris) in which the need to develop R & D associated with educational applications of the new information technologies was emphatically stressed, "the aim of R & D being not to see how hardware can enter the education system at all costs, but to what extent it could improve learning and education; how it could be prevented from fostering new forms of inequality and what effects it would have on the functioning of the school (learning processes, special content and subject areas)".

13. In January 1984 in the Netherlands, the Ministers of Education, Science, Economic Affairs, and Agriculture and Fisheries published a white paper "Informatics-Stimulation Plan" (ISP) presenting their Information Technology policy for the period 1984-1988. The paper states that "given the priority for education and information technology, one can say that that support by means of research, including policy evaluation, is at present insufficient".

14. It is interesting to compare these proposals with the recommendations emerging from CERI work in this R & D area in 1970. A CERI seminar at Portland, Oregon, United States, in October 1970 concluded that:

> "It is considered essential for the future development of computer-based learning that there should be more planning of the research programmes and financial support than they are given... One

significant aspect of the research that has not been given its due attention in the past is research which looks at questions oriented toward the problems of instruction in the context of ongoing instructional programmes. Most of the research in the past, it seems fair to say, has been research which has been oriented towards specific problems that are examined outside of an ongoing instructional programme but have presumed relevance to such programmes. This type of research needs to be given support as well but should not be the exclusive type of research that is supported and programmed in the larger plans on a national or international basis." (CERI, Technical Report of Portland Seminar, June 1971).

In Existing and also in Future Institutions and Centres

15. There is accordingly a need to develop R & D in education and the information technologies, and to start by strengthening existing teams. Here it is noteworthy that in 1984, the United Kingdom University Grants Committee allocated 46.5 teaching posts to information technology for the forthcoming academic year, and that 35 of these were mainly to strengthen research in the area. It is also relevant that the UK Government has accepted the recommendations for the "Advanced Information Technology Programme" in the report of the Alvey Committee (1982) and that £ 200 million will be available for the five years ahead.

16. The various reports all emphasize the need for co-ordination, at national level, of research between universities and other public sector, and also for links to be developed between the public and private sectors. To facilitate the co-ordination of research fragmented among a variety of teams and institutions, and also to encourage the multidisciplinary and interdisciplinary approach by bringing together scientists in different disciplines -- cognitive psychology, computing, artificial intelligence, education sciences -- some countries are contemplating new R & D centres. The Pittsburg Conference in the United States concluded: "The successful application of computers to education will require expertise in subjet matter, in teaching, in computer technology, in cognitive science and in design. It is therefore necessary to provide means for bringing individuals with these capabilities together into team efforts. To accomplish this objective we recommend establishment of at least two research centres dedicated to applying technology, and new knowledge of human cognition to improving education". To ensure healthy competition between ideas as well as good geographical access, two centres were recommended, one predominently for research on new applications of the computer in reading and writing and one predominantly for comparable research in mathematics and science. As a result of that recommendation, the first centre has been established at Harvard University in the mathematics and science field (see Annex 2, United States).

17. In the United Kingdom, the SSRC also reported that research programmes would require "a high degree of multidisciplinary collaboration" and that "there is a strong case for the establishment of a technology centre, inter alia dedicated to multidisciplnary research into aspects of the educational significance of information technology, with particular emphasis on the principles underlying the design and implementation of technology-aided learning experiences." That recommendation was accepted, and decisions about

the funding, size and location of the centre are expected during 1984. During its first phase, the centre is expected to circulate research findings, and to harmonize these with the needs of users and decision makers.

18. In the autumn of 1981, the French Institut National de Recherche Pédagogique (National Educational Research Institute, INRP), published a report "Dix ans d'informatique dans l'enseignement secondaire, 1970-1980" ('ten years of computing in secondary education, 1970-1980, INRP, 1981, Série Recherches Pédagogiques) which assessed the French "58 lycées" experiment. The report concluded that pedagogical research ought to be co-ordinated at national level by a multidisciplinary team. The research Director of the Ministry of Education, at a large scale Paris seminar on computers and education in November 1983, further to that conclusion, said that because computer-assisted education was multidisciplinary, the importance needed to be stressed of pedagogical research (mainly conducted by the INRP). It should be borne in mind that the cultural and economic impact of computer-assisted education might lead on to work in the human sciences. The Ministry of Education wished to structure that research by programmed topic activity contracts, which the Research Directorate would undertake jointly with the Ministry of Industry and Research, particularly its computer agency. A preliminary attempt at co-ordination had been in hand for more than twelve months under Professor J. Arsac; this involved some 30 researchers in teams, in different geographical locations, investigating specific problems in teaching computing by CAI methods.

19. Also in France, the Carraz report recommendation was to establish a National Educational Research Institute with more resources than the existing Institut National de Recherche Pédagogique, and differently designed. Within the new Institute a multidisciplinary centre would be established to specialise in research into pedagogical use of the new technologies "to ensure consistency among the many research avenues and the best possible co-ordination between the various teams and programmes (universities, INRP, National Educational Documentation Centre (CNDP), Mathematics Teaching Research Institutes (IREM). The centre's purpose should be to investigate and identify research needs, develop new languages and new educational hardware, and to provide teachers with help and advice. These research activities would only be feasible if conducted in association with the schools themselves, and involving researchers in subject-area teaching methods. A key component would have to be differentiation in cognitive learning styles so as to infer relevant pedagogical applications for the new technologies". The report to the Minister adds that the multidisciplinary centre would need substantial resources to promote its policy and would therefore require a net increase in the established posts at its disposal over the number at present allocated for research in this field.

20. In Australia, a proposal for the establishment of a research centre for the study of computer applications in education is under consideration by the Minister of Education and Youth Affairs and the Minister of Science and Technology. This centre will involve several universities, and the Commonwealth Scientific and Industrial Research Organisation.

R & D in the Following Fields

21. Each of the reports mentioned above lays down priorities and research proposals for its own country. It may be helpful to introduce them briefly so that in conjunction with the survey results, chapter 3 can identify possible topics for international co-operation.

22. In the United States, the Office of Technology Assessment concluded that there was a need for R & D focusing on:

i) Developing new techniques and tools for software development;

ii) Developing the human/machine interface;

iii) Improving the understanding of cognitive learning processes.

23. The Pittsburg Conference recommended the Federal Government to pursue research in the following directions:

i) Prototype research which will provide the necessary knowledge and experience for subsequent development of instructional systems and materials by private industry and schools, and fundamental research in laboratory settings on processes involved in skilled reading, writing, mathematics, science, and other intellectual activities; new ways to adapt instruction to individual differences in aptitude and progress in learning, and the psychology of student and teacher interaction with automated instructional systems;

ii) Associated fundamental research in specific activities from which shorter-term payoffs can be expected, e.g. the enhanced design principles for human/computer systems for education;

iii) Research on cognitive issues:

-- Resistance to the changes involved in this type of learning;

-- Improvement of understanding, reading and writing;

-- Knowledge structure;

-- Mental models;

-- Cognitive psychometrics.

iv) Research into other areas including motivation, the introduction of computers into education, the computer as an aid to the teacher, teacher training, school and class organisation, quality and assessment.

24. In the United Kingdom, the SSRC report suggests two directions for research:

i) Learning processes, assuming highly interactive software, focused on the styles, strategies and process of learning with information technologies. This would involve investigating individualised learning, distance teaching, associated information handling skills, software conceptualisation principles, social interactions, expert systems for education;

ii) The impact of technologies on curriculum and the efficient management of changes in educational practice and organisation.

25. In addition, the Alvey Committee, the Scottish Microelectronics Development Programme, the Scottish Council for Educational Technology, the Microelectronics Education Programme and the Council for Educational Technology are working on a wide range of software research (design, distribution, etc.), curriculum, teacher training, information and communications systems (Prestel), etc;

26. In France, the Le Corre - Pair report suggests research into:

-- Terminal specification (especially videodiscs);

-- Features of communications media;

-- Nature and presentation of information for exchange;

-- Man/machine interaction for education, information and documentation;

-- Forms of distance teaching;

-- Educational software design;

-- Problem solving;

-- Educational games;

-- Social and psychological aspects;

-- Involvement in local community;

-- Ergonomic aspects;

-- Assessment;

-- Special applications to various categories of the handicapped.

27. Meanwhile, the Carraz report suggested:

i) Putting work in hand on diversified ways of using the computer in teaching situations, starting with an inventory of existing practices;

ii) Closer analysis of mechanisms for expressing and understanding audiovisual messages, taking account of learning styles and of how the neurosciences are beginning to describe those mechanisms physiologically;

iii) Further work on the use of the re-recordable videodisc;

iv) Studies of the use of computers as part of teaching practice;

v) Studies of the underlying operational concepts (memory, programme, switching, coding etc.) and the various forms of awareness and construction by pupils: taught or self-developed;

iv) Introducing these technologies and educational applications within a broader cultural framework (technical culture dimension);

vii) Investigating arrangements for introducing technologies as training tools in industry;

viii) Pursuing the consolidation of work on artificial intelligence, cognition and educational software design with a view to devising expert systems and languages with which the user can program more independently.

28. In the Netherlands, the Informatics-Simulation Plan considers research projects in the following areas:

i) Applications of information technology to special education;

ii) The development of hardware, software and courseware in association with the industrial sector;

iii) Experimental projects giving practical results for an immediate demonstration effect.

29. Here again, attention is drawn to the 1970 Portland CERI Seminar on key R & D areas:

> "... the area of research that needs further development is that which is designed to look at both sides of the teaching/learning process, namely the instructional aspects and the students learning aspects as an interactive and two-sided operation. Research which relates learning to its avowed function is essential if we are to develop appropriate theories of teaching and theories of learning in cognitive development. Over the past decade our perceptions of what the computer might do in education have matured; ... there is a need to move off a base which has been primarily delivery systems oriented to ask sounder and more far reaching questions. Questions which computing systems could contribute to in a material way and in a way which would be different qualitatively to that in which the psychology of learning and cognitive processes have been developed in the past. The computer can give us a powerful tool for looking at interactive processes in ways that the media and other approaches do not. We need to think of

computers as instruments for developing the thinking processes; to serve individual differences in teaching styles and learning needs; and to stimulate creative activities in teachers and students. Computer-based learning has unfortunately inherited all the problems of education, and revealed them like a microscope showing that the resources necessary, and particularly the conceptual resources, for constructing an important and useful educational enterprise just do not exist."

Chapter II

TENTATIVE ASSESSMENT OF THE STATE OF RESEARCH AND DEVELOPMENT IN SELECTED MEMBER COUNTRIES

30. Since resources and time available preclude a very detailed picture of the various R & D activities in the new information technologies as applied to education in Member countries, this chapter presents information and trends emerging from contacts with research institutions in those countries expressing interest in such work. Accordingly, information was sought about the nature and scope of R & D programmes, as a basis for determining:

-- Areas where there are sufficiently active groups in Member countries to make an international co-operation programme possible;

-- Areas where there is need for an enhanced research effort.

31. For this purpose a questionnaire (CERI/NT/83.06) was devised in three parts. The first sought particulars of research groups (address, names of researchers, work already performed and recent publications and theses) and of the level of activity (budgets, funding sources and man/years). In the second part, research institutions were asked to classify their work under five broad categories:

i) Hardware for educational purposes;

ii) Systems for educational applications;

iii) Educational application software;

iv) The learning process;

v) Social and psychological issues;

vi) Programmes directed at professional development and training.

In part three of the questionnaire, the respondant was asked to summarise the group's work in under 500 words (CERI/NT/84.04 Annex 2).

32. The questionnaire was sent out in September 1983 to the various institutions, through the authorities in the countries concerned. The latter were Australia, Belgium, Canada, France, Ireland, Japan, Sweden, the

United Kingdom and the United States, (which offered a representative sample of R & D work). Questionnaires were received back between December 1983 and June 1984.

Main Findings from a Limited Survey

33. The survey was limited, first in not covering all OECD countries, and this largely accounts for the substantial differences observable between those countries that are already largely computerised, across the various socio-economic sectors, and other countries, but even the former display appreciable differences in the extent to which information technologies have been introduced into education (cf. CERI/NT/84.02). The survey was also limited by the fact that in the countries concerned, a number of research institutions either were not contacted or did not reply, or omitted some details they regarded as confidential. Lastly, the survey did not cover, deliberately at this stage, research in private sector computer firms, or in large public or private enterprises. Nevertheless, in the opinion of the authorities of the countries concerned, the information forwarded is representative of the type of R & D work, if not of the amount being conducted.

34. The survey covers a total of 122 research institutions of which 101 are universities (or higher education establishments), as follows:

Australia	17	of which	17	universities
Belgium (Dutch-speaking)	2	of which	2	universities
Canada	26	of which	25	universities
France	17	of which	13	universities
Ireland	2	of which	2	universities
Japan	25	of which	14	universities
Sweden	1	of which	1	university
United Kingdom	15	of which	15	universities
United States	17	of which	12	universities

Scale of R & D Universities

35. The first salient observation is the amount of interest the universities are taking in this type of R & D. The reasons are as follows:

i) Universities, long equipped with computers for fundamental research in physics and mathematics, later developed training for computer scientists. So they were already familiar with the computer as a tool. They naturally conducted the first experiments in computer-assisted education in the early 1960s and created the first software and courseware for their students, mainly in science. With the introduction of minicomputers and microcomputers into primary and secondary schools, universities used their long experience to create appropriate languages, authoring languages, software and educational packages, and sometimes hardware for primary and secondary schools;

ii) In a number of countries the universities are responsible for training information technology teachers for the schools;

iii) They have the necessary manpower resources for the multidisciplinary approaches required for R & D in these various areas;

iv) Education science faculties and departments feel that they are particularly concerned by this technological revolution and its consequences for teaching/learning processes and curricula;

v) They are expected to meet new training requirements for computer professionals and for those branches of industry which are rapidly evolving as the result of large-scale applications of the new technologies.

36 The universities' involvement here is a matter for satisfaction and in some countries may lead to stronger links between universities and society, especially industry, and between universities and primary and secondary schools.

Similarities, for Certain Countries, in the Number of R & D Institutions and Resources Allocated to R & D

37 Despite the many problematical aspects of this survey, the number of replies from institutions for each country was more or less the same. In other words, countries were taking about the same amount of interest in R & D for education and the new information technologies. A wider survey in the United States would probably have given a response rate of the same order, proportional to the higher number of research institutions there.

38. A brief review of such information as has been forwarded on R & D resource levels in terms of funding and man-years shows countries (see CERI/NT/84.04 Annex 2) to have four categories within which the research groups can be classified:

i) Smaller groups, most with no outside funding of between 0.5 and 3 man/years. Most of these are teachers researching in mathematics, physics and education sciences who have decided to focus their research on educational applications of the new technologies within their own teaching departments;

ii) Medium sized groups, many with more or less modest outside funding, of between 4 and 8 man years;

iii) Larger groups, with substantial resources, of 9 to 15 man years;

iv) Research centres and institutions with substantial financial and human resources, of 16 to 100 man years. Instances are the Harvard University's new Education Technology Center in the United States, the University of Calgary and the University of Waterloo in Canada, London University and the Open University in the United Kingdom, and the Institut National de Recherche Pédagogique, and the University of Paris VII in France.

39. This information must be treated cautiously, because not all institutions quoting resources in man/year terms specify whether their figure means the number of researchers per year or the number of researchers multiplied by the number of years the contract or programme runs. Harvard University, for example, quotes 108 man years for research over five years, i.e. about 22 researchers. Nevertheless, the human resources level would appear to be of approximately the same order in Canada, the United States, France and the United Kingdom, with the majority of research groups comprising between 4 and 8 man years and just a few very large groups. Australia seems mainly to have the smaller groups of 0.5 to 3 man years. Japan did not provide any information about human resources engaged in R & D.

Research Directions Generally Identical in Survey Countries

40. Part two of the questionnaire was designed to ascertain R & D directions. Annex I is a quantitative analysis of the 192 responses covering 117 institutions, some institutions covering more than one research centre, faculty or department. The University of Calgary, for instance, sent in 23 replies which were accordingly taken into account. For reasons concerned with the analysis of research activities in the various areas (listed in paragraph 31) as percentages of the total number of responses per country, countries with only one or two research institutions, i.e. the Dutch-speaking sector of Belgium, Ireland and Sweden, could not be included. Part Two, therefore, deals only with the following six countries: Australia (21 responses, 17 institutions), Canada (76 responses, 26 institutions), the United States (17 responses, 17 institutions), France (25 responses, 17 institutions), Japan (30 responses, 25 institutions), and the United Kingdom (23 responses, 15 institutions).

41. Since this report is intentionally geared to possible international co-operation, it neither discusses the broad R & D directions of individual countries nor makes any comparisons between countries. The reader is referred to Annex 1, which shows some interesting differences for particular research subjects. But those do not appear to undermine the following conclusions. On the basis of average percentages for all six countries, for every item under each of the main headings, R & D research areas can be ranked as follows:

a) Between 65 and 75 per cent of activities

-- 74 per cent of the R & D groups were involved in the use of the computer as a learning tool (CAI) [(ii)(a), Annex 1];

-- 65 per cent in educational software development [(iii)(a)].

b) Between 40 per cent and 50 per cent of activities

-- 49 per cent were involved in the identification of input and output devices [(i)(a)];

-- 43 per cent in CAI authoring languages and computer managed instruction [(ii)(f)];

-- 40 per cent in computers applied as laboratory instruments, and for data processing, CAD etc. [(ii)(b)];

-- 40 per cent investigating man/machine interaction [(iv)(c)].

c) Between 30 per cent and 39 per cent of activities

This range includes:

-- Using the new technologies to individualise education: 39 per cent [(iv)(a)];

-- Training teachers to use computers: 39 per cent [(vi)(d)];

-- Developing new hardware: 36 per cent [(i)(b)];

-- Using data banks, viewdata etc.: 33 per cent [(ii)(d)];

-- Using computers for remedial and handicapped pupils: 32 per cent [(ii)(c)];

-- Using computers to diagnose learning difficulties: 30 per cent [(iv)(b)].

d) Between 20 per cent and 29 per cent of activities

-- The impact of computers on learning processes (improving, understanding): [(iv)(f)] 28 per cent; [(iv)(d)] 25.5 per cent; [(iv)(e)] 20.5 per cent; [(iv)(g)] 20 per cent;

-- Activities relating to the social and psychological aspects of introducing the new technologies: [(v)(a)] 26 per cent; [(v)(c)] 23 per cent; [(v)(d)] 21 per cent;

-- Activities relating to professional training programmes: [(vi)(c)] 28 per cent; [(vi)(b) 22 per cent; [(vi)(a)] 22 per cent;

-- Distance learning and telesoftware: [(ii)(e)] 21.5 per cent.

e) Between 8 per cent and 19.5 per cent of activities

-- Hardware portability, protocols and standards, including distance learning applications: 19.5 per cent [(i)(c)];

-- Software and courseware portability: 18 per cent [(iii)(c)]; distribution techniques and processes: 15 per cent [(iii)(b)];

-- Other social and psychological questions, such as new responsibilities for families: 17 per cent [(v)(e)]; equality of opportunity: 15 per cent [(v)(f)] and changes in school organisation: 17 per cent [(v)(b)];

-- Ergonomic and medical aspects, only 8 per cent [(i)(d)].

Conclusions from questionnaire analysis

42. In accordance with the aims of the survey (cf. paragraph 30), general conclusions emerging are that:

i) The resources being allocated for R & D in educational applications of the new information technologies seem low in view of the challenge they represent for education;

ii) Fields in which countries have enough research groups to envisage co-operation are:

-- Computer-assisted education (CAI) in multimedia hardware configurations based on programming languages capable of developing student creativeness (e.g. Logo, MicroProlog-), educational software production, authoring languages and expert systems;

-- Use of the computer for a better understanding of and improvements to learning processes, to be applied first as a remedy to school failure.

iii) Fields in which R & D levels are found to be low are:

-- Distance learning;

-- Software and courseware portability, including telesoftware;

-- Social questions such as equality of opportunity for access to the new technologies in terms both of understanding and educational use, according to social and cultural background and sex;

-- Ergonomic and medical aspects.

Chapter III

INTERNATIONAL CO-OPERATION: NEEDS, RESEARCH TOPICS AND POSSIBLE ARRANGEMENTS

43. From analysis of the questionnaires and information contained in CERI/NT/84.04 Annex 2, and of R & D trends and proposals in the selected countries (see Chapter I), the following four broad research and development areas can be selected:

i) Software and courseware: design (pedagogical design, correction, preparation), tools (capabilities and utilities, programming languages, author languages, applications of artificial intelligence techniques i.e. expert systems), distribution (publishers, telesoftware, portability), quality control, uses (class, home), assessment and follow-up;

ii) Learning processes: use of the computer as a way of improving learning and as a research instrument with which to study the mechanisms of understanding and learning processes (study of differences between pupils, including remedy to school failure and the handicapped, individualisation of teaching, pupil/machine and teacher/machine interaction etc.);

iii) The use of the various new technologies for educational purposes: multimedia computer systems with a special emphasis on the re-recordable videodisc, distance learning (viewdata, satellites, optical fibres);

iv) Social and psychological aspects: especially equality of opportunity (boys/girls, different socio-economic groups, cultural and linguistic minorities) and resistance to innovation on the part of schools, teachers and parents.

Needs for international co-operation in R & D for OECD countries

44. There is a clear-cut distinction among OECD countries in introducing the new information technologies into the education system: one group is very advanced at all levels of the education system, another group is very advanced at the professional and technical education level, and a third group has not yet taken any significant decisions (cf. CERI/NT/84.02 and 03), partly because of doubts about the effectiveness of the technologies but also because they

cost so much to introduce (cf. report CERI/NT/84.06). In other words, assuming an irreversible trend towards introducing the new information technologies into education, and the need to derive the maximum advantage from them to improve learning, it is essential that international co-operation be useful both to the most advanced OECD countries and to the least advanced.

45. International co-operation in R & D should be both short-term and long-term. The least advanced countries have an immediate need for the experience -- successful and otherwise -- of the more advanced to determine their policies and strategies. At the same time, co-operation is needed in fundamental research geared to the future rather than to the present.

46. International co-operation should involve public sector research institutions including certain schools and teachers, together with the major public and private sector enterprises with long experience of using the new technologies in initial and continuing training. This is a really important point. Whether in developing educational software, using the various possibilities, produced with the aid of a variety of means such as videodisc, telecommunications, voice recognition etc. [man/machine interaction, graphics illustrations and digital pictures, laboratory experiment control, computer-assisted design (CAD), machine tools, robotics, telecommunications] or in assessing the results, including cost analyses, enterprises will be a source of much information that is not readily available in the formal education system, which would have a great deal to gain from it.

Possible research topics with which to make a start on co-operation

47. Various areas would lend themselves to co-operation, as mentioned in paragraph 43, but it would seem preferable to select, not necessarily exclusively, precise and restricted topics for the first phase, realistically and in the light of existing R & D. In the first phase, therefore, it is suggested that work should be done on prototypes with which to improve hardware and software for possible use in the following fields:

i) Arithmetic;

ii) Reading;

iii) Computer literacy;

iv) Elementary mechanics;

v) Physical geography;

vi) Boolean algebra;

vii) Foreign languages;

viii) The interface between microcomputers and simple and complex machinery.

48. These fields are suggested because they tie in with the need mentioned above for international co-operation. The latter would involve developing highly interactive software, whose cores could be transferred unmodified for

different hardware configurations, thereby ensuring portability, from the teaching standpoint, from one country to another, with countries making themselves responsible for any additions necessary to reflect teaching, cultural, social, historical or geographical considerations of their own. It would be hard to overemphasize the importance of achieving pedagogical portability of software from advanced countries to the less advanced countries, since good software costs so much to devise. Needless to say, agreements should be concluded among the advanced countries about copyright so as to make transfers to the less advanced countries acceptable.

Possible Arrangements for International R & D co-operation

49. Generally speaking, for the topics that the Conference might select (see paragraph 43) the next steps in the short term might be.

i) To set up specific international teams (four to five researchers, by topic, to advise Member countries upon request on any of those topics;

ii) Regular exchange of information about the state of research on particular subjects:

-- by distributing the proceedings of major conferences organised by Member countries;

-- by appropriate telecommunications systems among the researchers themselves;

-- by having the researchers meet once a year.

In this connection it is worth pointing out that universities and other research institutions in Member countries have already developed international contacts and wish to strengthen those links, as was mentioned in several of the survey respones.

50. More specifically (see paragraph 47), for the above proposals relating to co-operation on software and courseware, there would be a need to identify

i) A few Member countries (some very advanced, others much less interested in this form of co-operation;

ii) One or two subject areas, i.e. arithmetic, elementary mechanics (because of the sophisticated simulations already available in certain countries for the latter) and foreign languages;

iii) The institutions (universities, public institutions and private and public sector enterprises) in participating countries with experience in these fields.

51. Whatever the arrangements decided on, substantial funding would be envisaged to prepare and implement such international co-operation effectively. If such co-operation were to prove successful, even though on a modest scale at first (1985-1986), it could obviously lead later on to more ambitious substantially funded R & D programmes in international institutions

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and centres, which the countries concerned could consider setting up, recognising the need to put together their experience and resources on this highly complex and costly issue. As a first step it would be useful if interested Member countries agreed to set up an ad hoc group to follow up the conference conclusions in this area and formulate, together with the Secretariat, precise and realistic proposals for further action.

Annex 1

Quantitative Analysis of Responses to Part Two of the Questionnaire

Country	Total questionnaires analysed	Total research institutions
Australia	21	17
Canada	76	26
France	25	17
Japan	30	25
United Kingdom	23	15
United States	17	17
Total	192	Total 117

The following percentages under each heading (i), (ii), (iii), (iv), (v), (vi) and items (a), (b), etc. are calculated from the total number of questionnaires analysed. For example, under heading (i) item (a), the percentage for Canada is 49. This means 49 per cent of the 76 responses, i.e. that 37 research departments are working on the same topic: identification of available input/output devices.

Research and Development Areas	Australia	Canada	United States	France	Japan	United Kingdom
	(percentages calculated by country on the total number of replies per country)					
i) Hardware for Educational Purposes						
a) The identification of available input/output devices having educational applications.	48	49	59	8	50	55
b) The development of new or the identification of prospective devices that may have a radical effect on education.	38	44	41	32	20	41
c) Identification of needs for protocols and standards to facilitate the interconnection of equipment and the transferability of materials, including protocols for electronic data communications (e.g. for distance education).	19	30	12	16	13	27
d) Ergonomic and medical aspects of the new information technologies in their educational context.	14	11	0	0	10	14
ii) Systems for Educational Applications						
a) The use of computers in interactive learning applications such as direct instruction, exploratory learning environments, simulations, gaming, etc.	81	76	82	82	47	72
b) The use of computers as process control devices in technological and scientific studies, as tools by students in carrying out calculations, contructing graphical presentations, writing and correcting essays and in computer-related activities such as computer-assisted design.	38	44	59	24	30	41
c) The use of computers to meet the needs of individuals with specific learning difficulties or physical handicaps.	43	26	41	32	20	32
d) The use of retrieval systems such as data banks, question banks, videotex etc. and the development of skills in information handling.	48	32	30	20	40	27
e) The applications of communication systems, including both the more advanced educational use of existing systems such as telephone tutoring, teleconferencing and telesoftware (delivery of computer programs through the telephone system or the broadcasting networks) and the educational applications of advanced communications systems such as Direct Broadcasting by Satellite and Fibre Optics.	24	33	18	12	20	22
f) The application of information technology to improve the efficiency of the production of learning materials and in educational administration including student management (e.g. authoring languages, curriculum development systems and student performance monitoring systems).	62	48	47	36	26	41
iii) Educational Application Software						
a) The development of educational courseware products using computers, videodiscs and other presentational devices either alone or in combination.	67	63	82	72	57	50
b) Processes and techniques of distribution.	10	18	18	12	10	22
c) Transportability between systems, including translation between different programming languages.	19	27	18	20	6	18

Research and Development Areas	Australia	Canada	United States	France	Japan	United Kingdom
	(percentages calculated by country on the total number of replies per country)					
iv) The Learning Process: Exploration of the use of computers and related technology as a means of promoting learning and as a research tool for studying the process of learning						
a) The study of individual differences in aptitudes and performance and the use of technology in supporting adaptive learning.	33	30	65	28	33	32
b) The uses of computer technology in the diagnosis of learning difficulties.	38	18	47	40	20	18
c) The study of learner/machine and teacher/machine interaction.	38	27	47	52	20	55
d) The use of technology to collect and analyse data on learning behaviour as a basis for developing models of human learning.	19	24	29	24	20	36
e) The evaluation of curricula by computer based monitoring of learning.	24	17	29	0	26	27
f) The use of computers in modelling intellectual processes.	19	18	41	36	20	36
g) The impact of teaching computer science in general education, on the learning process.	24	19	23	20	14	18
v) Social Issues: Research on the social and psychological factors involved in introducing new educational technologies into existing social systems						
a) The study of resistance to technological innovation (particularly by teachers).	33	22	30	12	10	32
b) Changes in school organisation and school architecture brought about by the new information technologies.	10	13	35	8	13	23
c) The changing role of the teacher in the new technological school system.	24	20	35	20	6	32
d) The changing role of the educator in the new technological school system.	24	21	47	4	10	18
e) The changing role of the home and school in the development of childrens' learning.	14	6	53	4	3	23
f) The impact of the new information technology on equality of opportunity with respect to sex, minority groups and geographically isolated individuals.	28	8	30	8	3	14
vi) Programmes Directed at the Professional Development and Training in Educational Applications of the New Technologies Including Programmes Related to Research and Programmes Related to Teaching Activities						
a) New programmes or new course elements in existing programmes aimed at the training of specialist professionals.	24	26	47	20	3	14
b) Training of teachers in computer science.	28	20	23	28	6	27
c) New programmes or new course elements in existing programmes for non-specialists.	38	27	35	24	13	32
d) Training of teachers in using computers.	57	30	47	44	6	50